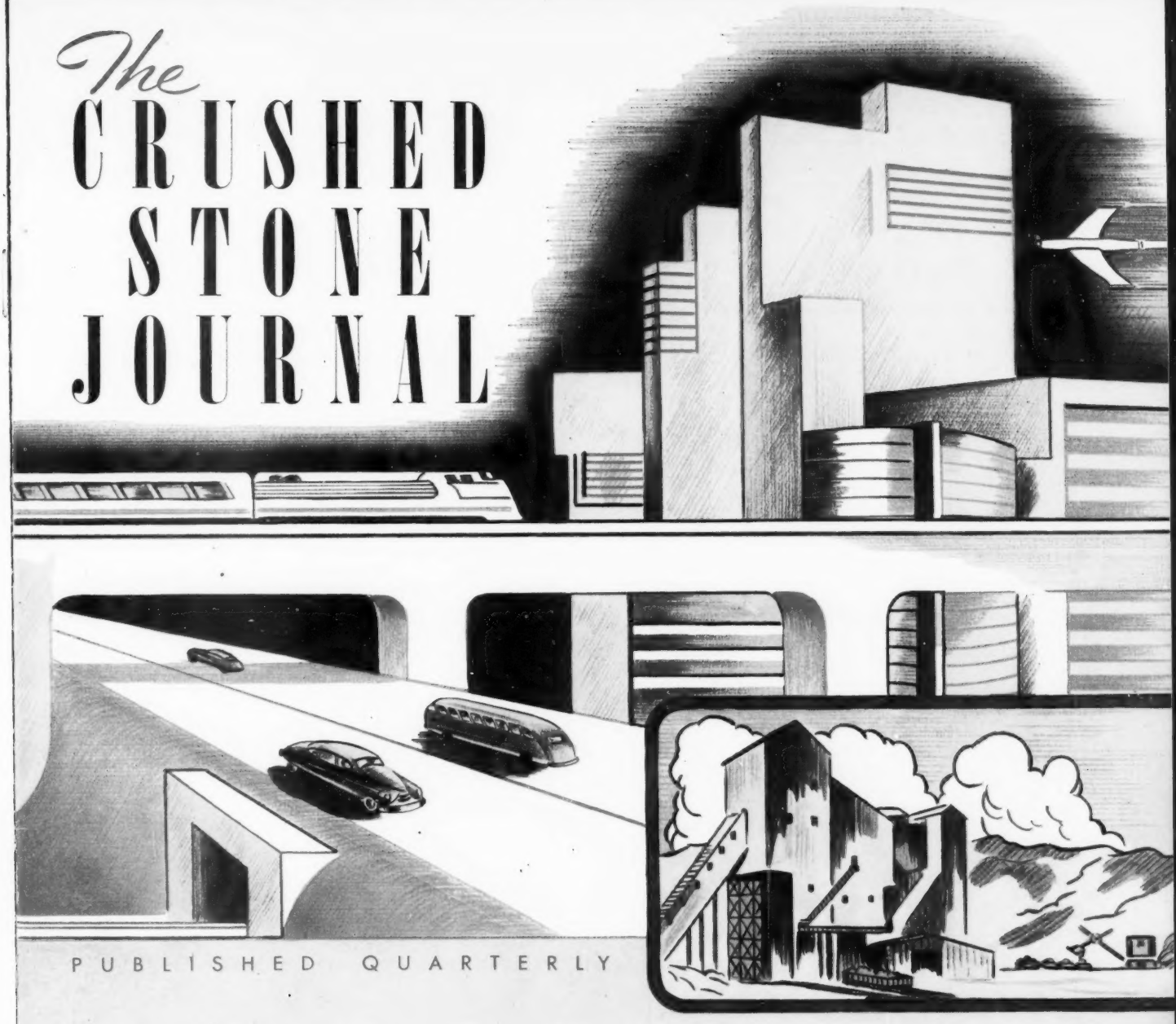
The CRUSHED STONE JOURNAL



PUBLISHED QUARTERLY

In This Issue

December 1955

- 39th Annual Convention
- Richard M. Prewitt Joins NCSA Staff
- United Front for a National Highway Program
- Highlights of Recent Activities at NCSA Laboratory
- Sixth Short Course of the National Crushed Stone Association
- John J. Forbes Retires As Director of U. S. Bureau of Mines

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National Crushed Stone Association

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The Crushed Stone Journal

Official Publication of the NATIONAL CRUSHED STONE ASSOCIATION

J. R. BOYD, Editor

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Contents

	Page
39th Annual Convention	3
Richard M. Prewitt Joins NCSA Staff	6
United Front for a National Highway Program By John N. Robertson	7
Highlights of Recent Activities at NCSA Laboratory By James M. Rice	9
Sixth Short Course of the National Crushed Stone Association By A. T. Goldbeck	18
John J. Forbes Retires As Director U. S. Bureau of Mines	20
Manufacturers Division Directory	21

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The Outstanding Event of 1956 for the Crushed Stone Industry

THE CRUSHED STONE JOURNAL

WASHINGTON, D. C.

Vol. XXX No. 4 PUBLISHED QUARTERLY DECEMBER 1955

39th Annual Convention To Be Outstanding Event of 1956

Record Attendance Expected In Chicago, February 20-22

Exposition Space Sold Out

FOR producers of crushed stone, the outstanding event of 1956 gets under way on February 20 with the opening of the 39th Annual Convention of the National Crushed Stone Association at The Conrad Hilton in Chicago. Scheduled through February 22, this year's Convention includes the added attraction of the Biennial Exposition of the Manufacturers Division and interest indicates that record-breaking numbers of quarry operators from every section of the United States and from Canada will be in attendance.

Delegates will be treated to one of the best-rounded programs in the long history of the Convention. Highly significant developments will be presented by industry members as they share the platform spotlight with nationally known speakers. Prominent too, will be the always popular social hours to provide the right touch in much-needed relaxation and pleasure. Executives, salesmen, superintendents, operating men—all will certainly find the diversified program interesting, entertaining, and highly beneficial.

In planning for this Convention, no segment of the crushed stone industry has been overlooked by the Convention Arrangements Committee under the able guidance of Chairman A. L. Worthen, while the painstaking efforts of Chairman B. R. Maloney and the Exposition Committee will be evident in the huge Exposition Hall where the latest in machinery, equipment, and supplies will be shown. Of particular interest to operating men will be the special session on Tuesday morning in which five highly important subjects have been arranged for by the Operating Session Committee under the competent chairmanship of George D. Lott, Jr.

Add to this the opportunity to visit with friends, make new contacts and acquaintances, and gain immeasurably through the exchange of ideas and fresh viewpoints and it becomes easy to see why attendance at this 39th Annual Convention of NCSA will assure every delegate of a profitable, practical, and pleasurable three days.

Make Hotel Reservations Now

Before bringing you a glimpse of 1956 program highlights, we would like to remind you to send in your hotel reservations immediately if you have not already done so. Convention time is rapidly approaching and reports from The Conrad Hilton coupled with inquiries received at NCSA headquarters indicate that early reservations are hitting a new high. There will be accommodations in the world's largest hotel for everyone, but reservations *now* will insure preferred consideration for your party. Should you need additional hotel reservation cards, please do not hesitate to contact the Washington office of NCSA.

To assist you further in eliminating last minute details, special advance convention registration cards will soon be in the mail to you. By promptly returning this card, your convention badge will be ready and waiting for your arrival at The Conrad Hilton.

Exposition To Display Latest Equipment

The Manufacturers Division Exposition continues to grow in importance and value. No effort has been spared by exhibitors in making their displays the most interesting yet and all available space in the Exposition Hall has been assigned for showing the latest developments of machinery and equipment used in the production of crushed stone.

Two full convention sessions, the first on Monday afternoon and the second on Wednesday morning, will be devoted to the Exposition. This arrangement provides full opportunity for all in attendance to obtain maximum benefit from a leisurely and studious inspection of the many outstanding exhibits.

At no other time and under no other circumstances until the Exposition is again held in 1958, will the quarry operator have the opportunity to view under one roof, the latest designs and developments in production equipment. Added to this is the advantage of consultation with the manufacturers' representatives who will be present to give you the benefit of technical know-how on the operation of this equipment as well as on problems of a highly specialized nature.

Federal Aid For Highways

The tremendous advantages to be obtained by attending this 39th Annual Convention will be quickly realized by a look at the subjects that will be covered.

President T. C. Cooke will formally open the Convention with a message of welcome to delegates after which will come a report on the results of elections held by the new Board of Directors at its organizing meeting on February 19. How your Association functioned in your behalf during the past year will be of great interest and this will be covered in the staff reports of A. T. Goldbeck, Engineering Director, J. E. Gray, Field Engineer, and Administrative Director, J. R. Boyd.

Everyone connected with the crushed stone industry is very much aware of the vital importance of a highway building program to the industry and of the significant role of Congress in legislating for a much-needed, improved, and expanded highway system. There will be excellent coverage of the highway picture, both visually and orally, on Monday morning. "Roadblock," an unusual color film, provides the visual side. Designed to encourage cooperative action and planning, the film also illustrates the very real road block of placing individual wants above the over-all good of improved highways.

But the film will only whet your appetite for the feature of the opening session—a talk by Arthur C. Butler, Director of the National Highway Users Conference on the subject, "Highway Legislation—What Happened and What's Ahead." A dynamic and forceful speaker, Mr. Butler will bring to convention delegates the most timely of messages in his review and preview of the extremely controversial highway legislation program. Those in attendance can indeed profit through the realistic approach of a man so close to this problem, a man long recognized as one of the outstanding authorities on highway matters.

At Monday's Greeting Luncheon, you will have the opportunity to hear the inspiring message that George A. Bowie brings in "Let's Get Personal." A Freedom Foundation winner of the George Washington Honor Medal, Mr. Bowie is noted for his talents in combining entertainment with information on what he calls "the world's most vital resource—its people." Many flattering recommendations from coast to coast stamp him one of America's top speakers.

A traditional feature of this luncheon will be observed when H. H. Kirwin, NCSA Accident Prevention Committee Chairman, gives well deserved recognition and presents awards to representatives of member company plants for achieving outstanding records in the National Crushed Stone Association Safety Contest.

Fun For All At The Cabaret

On Monday evening, the NCSA Cabaret will be the first of the popular social events of the Convention. Planned for your relaxation and enjoyment, soft lights and music will accentuate the informality of the night club setting. There will be dancing during the cocktail hour to be followed by dinner. The feature attraction of the evening will focus the spotlight on several nationally known acts by professional entertainers. Music for dancing will appropriately conclude this highly enjoyable evening at the Cabaret.

Special Session Stresses Operating Techniques

A look at how industry sees America in 1975 opens the Tuesday program. A spectacular film, "People, Products and Progress: 1975," produced by the Chamber of Commerce of the United States, forecasts what the future can hold for us.

The remainder of Tuesday morning will be exclusively devoted to five practical subjects that will

contain a veritable gold mine of useful information for operating men.

To open this special session, "Rock Breakage by Explosives," will be presented by Walter I. Duvall, Physicist of the Division of Mineral Technology, United States Bureau of Mines. "Latest Developments in Primary Drilling and Their Effect on Quarry Efficiency" will be discussed by a panel composed of Montagu Hankin, Jr., Executive Vice President, North Jersey Quarry Company, Summit, New Jersey; Harry H. Haas, General Manager of the Buffalo Crushed Stone Corporation, Buffalo, New York, and W. Irwin Gill, Sales Consultant, Gill Rock Drill Company, Lebanon, Pennsylvania.

Richard Robinson of the Massachusetts Broken Stone Company, Weston, Massachusetts, will handle "Methods and Operation of Surge Pile Storage" while John R. Kringel, Assistant to the Vice President in Charge of Operations for the New York Trap Rock Corporation, Newburgh, New York, will speak on "Problems of Overloading and Spillage in Highway Hauling."

"Methods of Centralizing Electrical Controls for Labor Saving" will be the subject of Alan K. Raney of the General Electric Company, Schenectady, New York. To allow for the many questions that are sure to follow these presentations, ample time has been provided for discussion periods.

Attention Manufacturers Division

For members of the Manufacturers Division, their Annual Luncheon and Business Meeting on Tuesday is one of the Convention's high spots. Officers and members of the Board of Directors will be elected for the coming year.

Subjects For Tuesday Afternoon

The program for Tuesday afternoon includes the presentation of three highly important subjects. "New Developments in Concrete" will be discussed by G. D. Kennedy, President of the Portland Cement Association, Chicago; "Significant Developments Regarding Insurance Subrogation Problems" is the subject of Warren C. Rowe, NSCA Subrogation Committee Chairman; and Donald D. Dagler, District Engineer, The Asphalt Institute, Harrisburg, Pennsylvania, will speak on "Plant Control of Bituminous Concrete Mixes." Many will be the benefits to be derived from the discussion period which follows this interesting session.

Tuesday evening will be open for individual plans and such group meetings as may be desired.

Eddy Gilmore Reports On Europe

On Wednesday morning, delegates will again have the opportunity to benefit from a close look at the many exhibits in the Exposition Hall. At the General Luncheon will come the unforgettable experience of hearing "Report on Europe" by Eddy Gilmore, the Pulitzer Prize-winning foreign correspondent of the Associated Press. Mr. Gilmore is no stranger behind the Iron Curtain of Soviet Russia, having put in 11 years as A. P. Bureau Chief in Moscow. The vivid accounts of his travels throughout Europe will also be included in his stirring up-to-the-minute "Report on Europe."

Flexible Pavements—Percentage Depletion Discussed

The design of flexible pavement is of basic importance to crushed stone producers. Years of research will be reflected in the paper of Raymond C. Herner, Airport Division Chief of the Indianapolis Technical Development and Evaluation Center, Civil Aeronautics Administration, when he speaks on "Designing Flexible Pavements for Strength—Not Thickness."

The concluding portion of the Wednesday afternoon session will find John F. Lane of Gall, Lane and Howe, General Counsel for the Association, reporting on "Most Recent Developments in the Field of Percentage Depletion" after which he will discuss the latest congressional activities in fields of particular interest to the industry. His appraisal of these highly important matters will be followed by a discussion period.

Wit And Humor To Feature Annual Banquet

A fitting climax to the 39th Annual Convention and Exposition takes place on Wednesday evening when everyone will gather for the traditional NCSA Reception and Banquet. With this the last opportunity for industry members to be together until a year hence, the emphasis will be on entertainment—and a past master as a laugh master, Tom Collins, will have you believing that "Two Plus Two Aren't Always Four" as he wraps a fresh new topic in a delightful package of wit, humor, and philosophy.

(*Continued on Page 6*)

Richard M. Prewitt Joins NCSA Staff

RICHARD M. PREWITT

THE National Crushed Stone Association announces with pleasure the appointment of Richard M. Prewitt as Assistant to the Administrative Director, on December 16. Mr. Prewitt comes to NCSA from the Chamber of Commerce of the United States and brings a varied and interesting background of knowledge and experience in the fields of organization and management work.

A native of Florida, Mr. Prewitt majored in Business Administration at the University of Florida. Coming to Washington, D. C. in 1939 to accept a position with the Farm Credit Administration of the Department of Agriculture, he continued his formal education at George Washington University while in the Planning Section of FCA.

As part of the Government's decentralization program in 1942, Mr. Prewitt assisted in the technical planning of the agency's transfer to Kansas City, Missouri, after which he enlisted in the Air Cadet program of the Army Air Force early in 1943. Upon completion of training, he was assigned as a B-17 pilot and served with the Eighth Air Force in England where he was awarded the Air Medal with three Oak Leaf Clusters for participation in 25 combat missions.

Returning to civilian status in 1946, Mr. Prewitt resumed his government career and in 1947 was appointed a member of the management staff of the Treasury Department. He continued in this capacity until late 1950 when named to the staff of the Office of Price Stabilization as a Section Head of the Administrative Division.

In March of 1953, Mr. Prewitt joined the staff of the Chamber of Commerce of the United States. As Administrative Assistant in the Service Department and later as Assistant to the Manager of the Manufacture Department, a major portion of his work was devoted to the issuance of publications, the planning and staging of field conferences and in surveying, analyzing, and publicizing the results of operations of chambers of commerce throughout the United States. A graduate of the Southeastern Institute of Chamber of Commerce Executives, he also worked closely with local organizations on their industrial and community development programs and with the American Industrial Development Council.

Mr. and Mrs. Prewitt and two sons make their home in Arlington, Virginia.

39th Annual Convention To Be Outstanding Event Of 1956

(*Continued from Page 5*)

When it comes to entertaining an audience, Mr. Collins has no peer and his exhilarating theme will provide the perfect finale to this Convention.

Special Program Planned For Ladies

It goes without saying that we thoroughly enjoy having the ladies attend the Annual Convention. Their presence in ever-increasing numbers has been one of the gratifying developments in the long history of these conventions.

With special program plans for the ladies virtually completed, they will be assured of a highly enjoyable time at this 39th edition of the Convention. A get-acquainted tea on Sunday, the popular social coffee hours each morning, Tuesday's Ladies Luncheon, tickets to telecasts and radio broadcasts—these are but a few of the special entertainment features.

In addition, much of the regular convention program will be particularly appealing to the ladies—the Monday and Wednesday luncheons, the NCSA Cabaret on Monday evening and, of course, the social highlight of the Convention, the Reception and Annual Banquet on Wednesday evening.

All Are Cordially Invited

In the foregoing, you have been given an all too brief preview of the many benefits and pleasures in store for you at the forthcoming 39th Annual NCSA Convention and Exposition.

All crushed stone producers and others interested in the industry are cordially invited to attend this convention.

Plan now to be with your fellow producers in Chicago on February 20, 21, and 22, and share in this, the outstanding event of 1956 for the crushed stone industry.

United Front for a National Highway Program[1]

By JOHN N. ROBERTSON

President
American Road Builders' Association

Director of Highways, District of Columbia
Washington, D. C.

MY few words today will deal with the subject that, from a national viewpoint, is of prime concern to us. I am referring to the efforts which are going forth to provide a long-range national program of expanded federal aid for highways. We were all keenly disappointed at the failure of legislation in the last session of Congress. The final responsibility for the failure rested with the House of Representatives. The Senate acted with considerable dispatch and approved and sent to the House a bill by Senator Gore of Tennessee.

To a large extent, the Gore bill was disregarded on the House side and instead, efforts were made to gain approval of a bill by Congressman Fallon, chairman of the House Subcommittee on Roads and for a bill by Congressman Dondero of Michigan, who sought approval of the finance recommendations of the Clay Committee—the advisory highway group to the President. Efforts to enact either of these bills, and two other proposals, met with resounding defeat and the eventual outcome was that all measures brought before the House were rejected.

What were the reasons for the legislative defeat in the House? Quite simply, I would describe as a contributing factor, partisan politics. For the first time in the history of federal highway legislation, in the House especially, party lines were formed and considerable political heat generated in debate over differences in the plans presented. Second, I would say that a serious reason for defeat of the legislation arose over jurisdictional differences between House Committees, especially (but not exclusively because there were other clashes of authority) in connection with the efforts to write in tax provisions as was the case in the Fallon bill and in creating a financing corporation as was provided in the Administration bill. Next, I feel sure that the inclusion of a number of extraneous features in what should have been a purely highway authorization bill, aroused unnecessary pressures and objections. And last, and most importantly, defeat came to the proposals because they failed to provide a realistic measure for a *well-balanced* national program. By that I mean that opposition quite naturally developed toward a plan that sought to invest over a score of billions into one system composed of a relatively small mileage without commensurate provision for other federal-aid systems. I am referring in this case to the Interstate System, and while we all agree that the economic and defense needs for the completion of that system requires favored treatment, nevertheless the heavy and increasing deficiencies in the primary and secondary federal-aid systems, including designated urban routes, is such that a great bloc of Congressmen feel, and I believe properly so, that fair and proportionate attention to these serious deficiencies must go along apace with improvement of the Interstate System. Such consideration would provide what ARBA calls a *well-balanced* program.

In summation of the reasons for the legislative defeat I would say that the bills were beaten because of a combination of objectionable features. This is surely a more accurate conclusion than the headline-catching stories that went out about last August to the effect that a single lobby defeated the highway bill. I don't think we should take stock in headlines like that because the causes for delay and defeat were much more substantial and Members of Congress were influenced by a variety of basic issues.

One thing that we might well fix in our minds is that the enactment of major legislation (and in this case we are speaking about the largest public works program in the history of the world) always comes about through a reasonable compromise of differences. Highway officials and those who are part of the great highway industry and the engineering profession will do well to maintain an attitude of flexibility toward legislative proposals. There are bound to be varying opinions, but men of good will can always compose their differences. I am not suggesting that anybody should sacrifice basic prin-

[1] Presented at the Illinois Road Builders Association, 18th Fall Meeting, Palmer House, Chicago, Ill., Nov. 17, 1955

ciples, but we do need a united front with a common objective. With that unity we can push forward a national highway program, yielding to such reasonable adjustments as may be required. Organized minorities have often been able to scuttle important bills in Congress. This does not have to happen to highway legislation, but the fact that it could happen is sufficient reason for all of us to get together in support of certain basic legislative principles of which we can all agree.

As far as the American Road Builders are concerned, we are ready to work hand-in-hand with the Illinois Road Builders and the other great contractor affiliates of ARBA, with highway officials, and with other cooperating interests to advance sound recommendations for an equitable national highway program.

To this end, ARBA has spelled out its position for the purpose of establishing a base for further deliberation and determination. We have made a 13-point statement of our national Association's position with respect to an accelerated federal-aid highway program. I want to make it absolutely clear that this 13-point Statement of Position is not intended to be dogmatic in any way. ARBA is maintaining the same degree of flexibility that we are suggesting you observe, but we thought it might be helpful, and we present it in the spirit of helpfulness, as a kind of base that we can discuss, and perhaps criticize, in an effort to establish viewpoints that will represent our common wishes. We hope that, in this way, we may stimulate greater unity in the direction of our efforts in support of a national program. Let me briefly review the highlights of the 13 points we have drawn up in an effort at clarification. The full text of this statement is available to any and all of you and we hope we will have the benefit of your views, comments, and suggestions.

We offer these 13 points as desirable for consideration in any future long-range accelerated program of federal aid for highways:

1. ARBA expresses full confidence in the traditional federal legislative policy which, for 40 years, has provided a joint cooperative federal-state program based on matching funds with primary responsibility vested in the states.

2. We agree that deficiencies in all of the federal-aid systems should be corrected within a reasonable period of time, preferably 10 years.

3. Federal assistance to the states should be extended on the basis of a *well-balanced* program, i.e., the orderly, proportionate and, so far as practicable, concurrent improvement of the federal-aid interstate, primary and secondary systems, including the designated urban highways.

4. Completion of the interstate system is of vital importance to the national defense and economy and merits special consideration, with the federal government assuming at least 90 per cent of the cost.

5. The federal government should, as in the past, extend 50 per cent of the funds for improvement of the federal-aid primary and secondary systems, including the designated urban highways.

6. Employment practices and prevailing wage scales on federal-aid work should remain a matter for determination by each state—not by the federal government.

7. Administration of federal-aid for highways should remain a function of the U. S. Bureau of Public Roads.

8. With reference to financing, owing to the complexities involved in federal fiscal matters, ARBA takes no positive position as to specific revenue measures. It is the Association's broad opinion, however, that the financing of an accelerated highway program should be through Congressional authorizations made upon the general funds of the Treasury, as in the past, and not related to any specific source of revenue.

9. ARBA accepts the estimates of cost for bringing our federal-aid systems up to standard as made by the state highway officials and the federal Bureau of Public Roads—such cost being based on a 10-year program to correct all deficiencies in the interstate, primary, and secondary systems, including designated urban highways.

10. We suggest that $68 billion is the only acceptable estimate of the cost of correcting the deficiencies in the federal-aid systems and that it might be an appropriate division to assign $43.5 billion of this to the federal government and $24.5 billion to the state and local governments.

11. ARBA suggests that any large-scale, long-term national highway program be carried on in a gradually stepped-up manner. We further suggest that federal and state funds be expended at first on a relatively modest basis and then gradually increased over a period of 3 years, by which time it might well reach its maximum tempo and be carried forth at that level. For sound, economic reasons it might be desirable to gradually taper off the program toward its conclusion, especially if the plan envisions com-

(*Continued on Page 17*)

Highlights of Recent Activities at NCSA Laboratory

By JAMES M. RICE

Research and Testing Engineer
National Crushed Stone Association
Washington, D. C.

CRUSHED stone is primarily a construction material. While large quantities are consumed in chemical and processing industries, about two thirds of the total production of commercial crushed stone goes into construction of pavements, railroad bases, and concrete structures. By itself, stone is used principally as a foundation and surface material for pavements and railroads. The other major use is for the aggregate portion of portland-cement and bituminous concrete.

Any construction material must have certain physical properties according to its use. The physical properties of rock are largely inherent. The stone producer has some control over certain aspects such as size, gradation, particle shape, and presence of deleterious materials. But he cannot economically change such qualities as hardness, strength, density, porosity, surface texture, alkali reactivity, or thermal characteristics.

In the mineral aggregates field, the properties necessary for a particular application are based on experience. Performance in service is the ultimate test of a material. Due to the time required to obtain field performance results, the materials testing engineer employs accelerated tests which aid in predicting the serviceability of a given material. These tests are not always reliable because it is difficult to simulate in the laboratory the conditions of service required of the aggregate. But, as our knowledge increases, test methods and acceptance criteria are constantly being improved. Furthermore, by judicious use, the engineer can often overcome certain undesirable properties of an aggregate. Improvements in the use of economically available aggregates are research problems which are continually being studied in the field and laboratory.

Scope of Activities

The purpose of this article is to describe some of the recent activities at the NCSA laboratory in the testing and use of crushed stone as a construction material. During the past six years the laboratory has received more than eleven hundred samples for testing. Most of these samples have been in the form of ledge rock, cores, crushed stone, and stone sand. The list also includes such diverse items as portland cement, concrete additives, asphalt, antistripping agents, waterproofing materials, etc. These materials have been tested as parts of individual test programs or projects. During the period under discussion, the laboratory has undertaken more than two hundred and fifty distinct projects. These range from simple tests, such as a sieve analysis, to investigations of the utmost complexity. For one project involving cement-aggregate reaction, the laboratory has fabricated eleven hundred concrete beams and mortar bars. These specimens have been measured periodically to determine growth or expansion. Expansion readings for this single project now total more than twelve thousand.

The projects may be grouped in several categories, i.e., research work of a basic nature of benefit to the entire industry, investigations of special problems for individual or groups of members, and standard tests for members. In the field of standard tests we are frequently called upon to make cooperative and referee tests—important functions of the NCSA laboratory. While we try to be letter perfect in the conduct of standard tests, such as abrasion and soundness, we also experiment with test variables. Furthermore, the laboratory is equipped to perform many tests which are rather unique, yet which provide valuable information about the physical properties of stone and portland-cement or bituminous concrete. The test program for a particular project is governed by the information sought and the facilities available, i.e., equipment, personnel, and time. A brief description of a few of the general and special interest investigations will illustrate the scope of our activities.

Concrete Design Investigations

One major undertaking has been the revision of NCSA Bulletin No. 11 which describes a method of proportioning concrete. The revision was desirable so as to include specific tables for air-entrained concrete, and to adjust and extend the data for concrete containing small sized aggregate. The laboratory participated in the revision by testing several series of concrete mixtures with different types and sizes of aggregates, both with and without entrained air.

We also are often called upon to design and test concrete mixtures using specific aggregates. A recent project involved the comparative flexural strengths of air-entrained pavement concretes made with gravel and crushed stone coarse aggregates. Both of these aggregates were high quality materials. The fine aggregate was a natural sand. Figure 1 shows how the strength of concrete beams

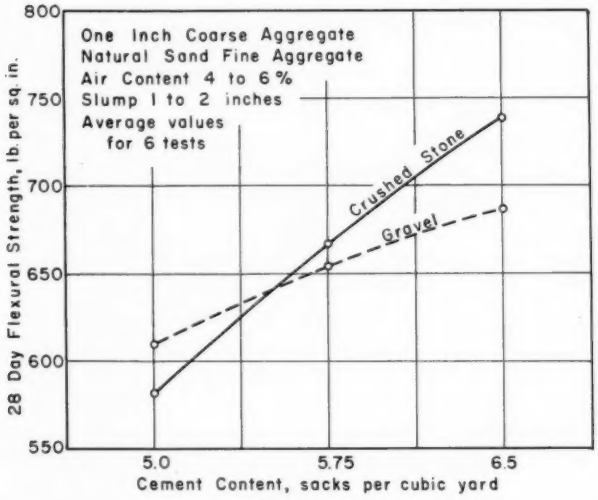

FIGURE 1
Effect of Type of Coarse Aggregate on Flexural Strength of Concrete

varied with the cement content. The gravel mix produced slightly higher strengths with low cement contents, but the stone mix was much stronger with the high cement content. The explanation for this phenomenon follows. Structural failure of concrete takes place through the line or plane of least resistance. In low strength mixtures (low cement content) failure occurs through the mortar. As the cement content is increased, the mortar becomes stronger, approaching that of the coarse aggregate. Failure may then take place by shearing through the aggregate. However, to do so, there must be a strong bond between the mortar and the coarse aggregate. This high bond strength is more easily attained with rough-textured, angular aggregates than with smooth, rounded ones. With the latter type of aggregate it may be impossible to develop sufficient bond strength to effectively utilize the full potential strength of the aggregate particles.

In another case, a producer received complaints that his stone sand contained too much stone dust. Now, fine material in a natural sand is very likely to be clay, which may be deleterious in concrete. Stone dust may contain some clay, although this is unusual. The problem remained as to how much stone dust could be tolerated. In this investigation, the amount of stone dust (minus 200 mesh) was varied from 3 to 9 per cent. Within this range neither workability nor strength were harmed by increasing amounts of fine material. The compressive strengths were actually greater with the higher dust contents. The results of this investigation are shown in Table I.

TABLE I

Effect of Dust Content of Stone Sand on Properties of Concrete

Structural Grade Concrete, Not Air Entrained
1 in. Stone Coarse Aggregate

Mix No.	A-1	A-2	B	C	D
Dust Content of Stone Sand					
Per Cent passing No. 100 sieve	6.0	6.0	9.0	12.0	15.0
Per Cent passing No. 200 sieve	3.0	3.0	5.0	7.0	9.0
Cement Factor, sacks per cu yd	6.5	6.7	6.5	6.5	6.5
Mixing Water, gal per sack	39.2	38.0	38.0	38.0	38.0
Slump, in.	3 3/4	3	3	3	3 1/4
Compressive Strength, 28 days, psi	5460	5620	6135	6310	6265
Flexural Strength, 28 days, psi	913	998	962	984	973

It should not be concluded that the dust need not be controlled. For example, in another investigation, an unprocessed stone screenings containing over 25 per cent dust was compared with a washed stone sand containing less than 6 per cent dust. Both aggregates were from the same quarry. It was found that in lean concrete mixtures (4-5 sacks of cement per cu yd) the high dust content was not particularly detrimental. With higher cement contents the water requirement for the screenings mixture became excessive, with a consequent lower

strength as compared to the stone sand mixture. Screenings with high dust contents should not be used even in low strength mixtures without thorough investigation.

Durability of Concrete Aggregates

The laboratory is frequently requested to assess the durability of samples of crushed stone, particularly with reference to concrete. Stone particles usually contain pores which may be more or less saturated with water. When water freezes it increases in volume about 10 per cent. If the stone is highly saturated, this increase in volume exerts internal pressure. When the individual stone pores are relatively large, the water can move readily and dissipate the pressure. However, small pores resist the flow of water and the pressure builds up. This pressure, if greater than the tensile strength of the stone, may either fracture the stone or cause expansion without apparent fracture. In concrete, repeated increments of expansion may cause the whole structure to expand. Another possibility is that the internal pressure will find relief by expelling water or ice into the surrounding cement paste. This may eventually cause disintegration of the mortar.

The laboratory uses a number of tests to evaluate resistance to freezing and thawing. One or more of the following procedures may be employed:

1. Examination for deleterious materials—chert, shale, etc.
2. Sulfate Soundness—sodium and magnesium salt tests
3. Freezing and thawing tests on crushed stone or ledge rock pieces
4. Freezing and thawing tests on core specimens prepared for expansion measurements
5. Freezing and thawing tests on concrete specimens

No one of these methods is at present considered completely reliable, but each provides some information. If an aggregate fails all tests, there is no question about its lack of durability. Likewise, if it passes all tests, it is certainly sound. But frequently we find discrepancies, as will be illustrated.

Table II shows the results of several recent durability investigations in which a total of 26 crushed stone samples were tested both by freezing in concrete and accelerated soundness tests on the aggregates alone. The concrete mixtures all contained entrained air and the aggregates were presoaked at least 18 hours before mixing. Concrete beams were kept moist until the freezing tests were commenced. Most of the results are for beams subjected to slow freezing and thawing in air, with a water soaking period injected after thawing. A few of the results were obtained by rapid freezing in air and thawing in water (ASTM Designation C 291-52T). These exposures were continued for 300 cycles, or until failure was indicated by the resonant frequency method (durability factor less than 60 per cent).

The accelerated durability tests on the aggregates alone were either sulfate soundness or freezing tests. The sulfate soundness tests were performed according to ASTM Designation C 88. There is at present no ASTM method for conducting a freezing and thawing test on crushed stone. Our procedure for the freezing test is similar to AASHO Designation T 136. A loss in weight of more than 12 per cent is usually considered excessive for either test method.

The results in Table II, when judged by the above criteria, show that 14 of the 26 aggregates failed in the aggregate soundness tests, but 9 of these "unsound" aggregates were durable in concrete. Eight of the aggregates failed in the concrete test, but 3 of these passed the aggregate soundness tests. Assuming that the concrete durability test results are reliable, it is apparent that the tests on the aggregate

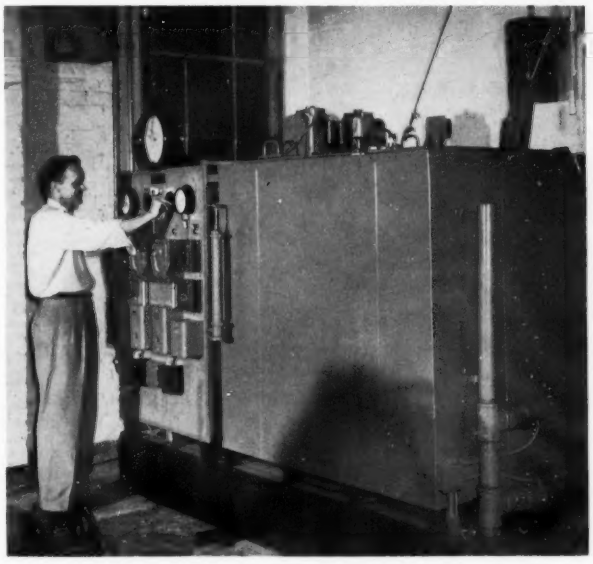

FIGURE 2
Automatic Freezing and Thawing Apparatus

alone would have rejected 9 sound aggregates and accepted 3 non-durable aggregates.

Durability tests on concrete have not been widely used for acceptance tests due to the time element. Using a slow freezing cycle in which the beams are transferred by hand, it may be possible to obtain only 5 cycles a week. At this rate, 300 cycles would require more than a year. In 1954, the NCSA acquired an automatic freezer (See Figure 2) with which it is possible to obtain 10 cycles per day continuously, or 300 cycles in 30 days.[1] The new freezer has been used for a number of projects, among which has been a cooperative investigation of the freezing test procedure itself.

Core Expansion Tests

One additional method for evaluation of durability is the core expansion test. In this test 2 by 1 3/4 in. diameter cores are drilled from ledge rock, the ends are sawed and ground smooth, and then the linear expansion caused by freezing and thawing is measured by means of a comparator (see Figure 3). The initial saturation condition of the cores may consist of 24 hour immersion, prolonged immersion, or saturation under vacuum. The most realistic saturation treatment would be that which approximates the condition under which the aggregate is actually used. Unless a stone is normally used in a quarry-wet condition, the cores are presaturated by 1 to 3 days immersion from an air-dry condition. The cores are frozen in air, not water, but drying is retarded by wrapping the cores with aluminum foil. Formerly, cores were subjected to slow freezing and thawing in air with a period of immersion while thawed. Now, with the automatic freezer, the cores are exposed to a rapid freezing-in-air, thawing-in-water cycle. The exposure is

[1] See *Crushed Stone Journal*, September 1954

TABLE II

Durability Results for Crushed Stone Samples in Air-Entrained Concrete

(In order of decreasing Durability Factor)

Lab. No.	Cement Factor, sacks per cu yd	Mixing Water, gal per cu yd	Air Content, per cent	Durability Factor[1], per cent	Soundness Losses for Stone Alone[2]
4384	5.9	31.6	3.8	103	20.9% in 5 cycles $MgSO_4$
4408	5.9	34.1	5.3	101	0.7% in 50 cycles Freezing
4849	6.0	30.5	4.9	101	4.9% in 50 cycles Freezing
4579	5.5	29.2	5.5	100	1.9% in 5 cycles $MgSO_4$
4406	6.0	34.0	3.9	100	3.9% in 10 cycles $MgSO_4$
4578	5.5	29.6	4.9	99	14.5% in 5 cycles $MgSO_4$
4388	5.9	33.8	6.0	99	4.8% in 10 cycles $MgSO_4$
5140	5.8	33.8	6.8	98	15.6% in 5 cycles $MgSO_4$
5194	6.0	36.1	5.4	98	14.8% in 5 cycles Na_2SO_4
5195	6.0	36.3	5.2	98	31.2% in 5 cycles Na_2SO_4
4375	6.0	31.8	5.4	97	13.6% in 5 cycles $MgSO_4$
4676	5.5	32.2	6.0	97	6.1% in 5 cycles $MgSO_4$
4596	6.5	33.4	3.7	96	19.8% in 5 cycles Na_2SO_4
5134	5.5	29.0	4.9	93	10.7% in 5 cycles $MgSO_4$
4376	6.0	31.2	5.2	92	11.8% in 5 cycles $MgSO_4$
4848	6.0	30.3	6.0	80	4.3% in 50 cycles Freezing
4278	5.5	34.3	5.9	69	15.7% in 5 cycles Na_2SO_4
4323	6.5	40.0	6.2	65	15.4% in 5 cycles Na_2SO_4
4644	6.5	34.3	5.5	53	10.9% in 5 cycles Na_2SO_4
4652	6.5	35.5	5.8	53	7.8% in 5 cycles Na_2SO_4
4645a	6.0	32.4	5.8	53	19.3% in 50 cycles Freezing
4646b	6.0	32.4	6.3	53	18.0% in 50 cycles Freezing
4830	5.7	33.6	5.7	44	13.8% in 50 cycles Freezing
4828	5.7	33.6	6.1	37	13.2% in 50 cycles Freezing
4829	5.7	33.6	6.0	37	7.5% in 50 cycles Freezing
4986	5.5	28.3	6.3	11	45.9% in 5 cycles $MgSO_4$

[1] Less than 60 per cent considered failure

[2] More than 12 per cent considered excessive

usually terminated at 50 or 100 cycles, or sooner if the measured expansion exceeds 0.1 per cent.

The laboratory has performed this test on more than 300 cores representing various ledges from several quarries. The method seems particularly useful for detecting the presence of non-durable ledges in a quarry. One advantage of this procedure over soundness tests in which only distintegration is measured is that it will detect aggregates which may expand without apparent fracture. In several instances we have been called upon to investigate quarries the stone from which is apparently sound as measured by sulfate soundness and unconfined freezing tests. Yet the stone has allegedly caused excessive expansion and blow-ups in concrete pavements. By detecting the expansive ledges, we have been able to recommend selective quarrying so as to eliminate the offending stone. Thus, quarries that would have had to curtail their activities, or perhaps shut down, have been able to continue in operation.

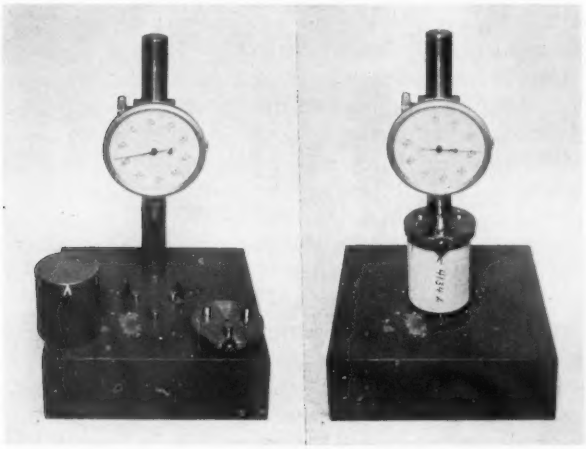

FIGURE 3
Core Length Comparator

In addition, we have been able to show that *high* absorption, per se, is not necessarily proof of unsound aggregate. On the other hand, certain aggregates with *low* absorptions may have a tendency to expand.[1]

Acid Resistant Mortars

One investigation of particular interest to limestone producers dealt with the resistance of mortars to corrosion by acids. Concrete pipe is frequently exposed to acidic water, with resultant disintegration and loss of strength. To evaluate the relative acid resistance of mortars containing siliceous and calcareous aggregates, 2 by 2 in. cubes were made with 3 different types of cements, Types I, II, and III. One series contained Potomac River natural sand, a predominantly siliceous aggregate, and acid resistant. The fine aggregate in the other series was a manufactured limestone sand. Limestone and dolomites are, of course, not particularly resistant to acid attack. These cubes, duplicate specimens for each mix, were placed in individual containers and covered with a mild sulfuric acid solution (initially 2 per cent). The specimens were weighed periodically to determine change in weight. Figure 4 shows the rate of weight loss. These results show that the siliceous mortar cubes suffered about 3 times the loss of the calcareous mortars. This may seem incongruous, but apparently the acid attacked only the cement in the siliceous cubes, consequently more cement was affected and more particles of sand were dislodged. The corrosive effect on the limestone cubes was shared by the sand particles resulting in a more uniform attack of less depth.

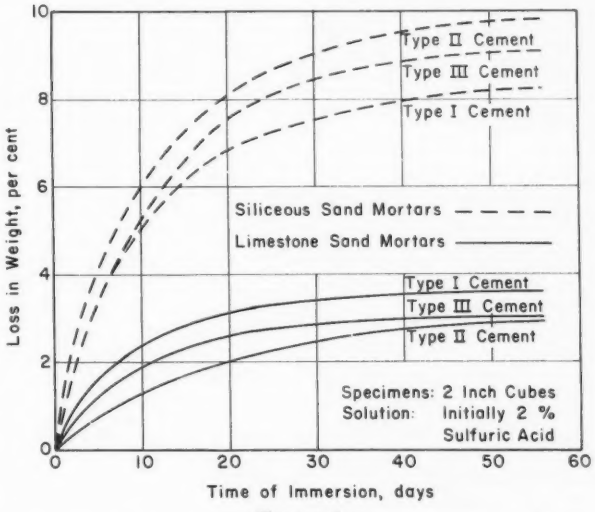

FIGURE 4
Effect of Type of Sand on Acid Resistance of Mortars

Crushing Resistance Tests

The crushing resistance test has been applied to coarse aggregates that are used for railroad ballast and road bases. In the process of construction these materials are subject to tamping or rolling which

[1] See Discussion of paper by Lewis, Dolch, and Woods, *Proceedings*, Am. Soc. for Testing Materials, Vol. 53, p. 959 (1953)

may result in considerable degradation, particularly with relatively soft materials. The test consists of first filling a 13 by 12 in. diameter steel container in 3 layers by the "jigging" procedure (ASTM Designation C 29). From the volume of the container and the weight of material it is possible to calculate the "compact" weight per cubic foot. Then the sample is subjected to a pressure of 1,000 psi applied through a bearing block slightly smaller in diameter than the steel container. The settlement of the plate is measured during compaction and from this measurement the final volume of the sample may be calculated.

Table III shows the results of this crushing test on several crushed stones and slags. The values reported are the initial and final densities and the percentage reduction in volume. These results are significant because aggregates are sometimes purchased on a volume basis, and the volume measurement may be based on the "compact" weight determination. But this measurement neglects the fact that aggregates lacking structural strength will suffer more degradation and disintegration when compacted under pressure. For example, a given volume (as measured by jigging) of the relatively hard trap rock (No. 4281) would provide about one-third more final thickness than the weak slag (No. 4304).

TABLE III

Effect of Compaction on Various Aggregates

Lab. No.	Type	Density, lb per cu ft Jigged	Density, lb per cu ft Crushed	Reduction in Volume, per cent
4281	Trap Rock	113.0	121.1	6.7
4283	Quartzite	97.9	108.0	9.4
4395	Limestone	100.8	112.8	10.6
4282	Limestone	99.7	112.9	11.7
4358	Limestone	97.2	110.6	12.1
4293	Limestone	93.4	110.3	15.3
4396	Slag	84.1	98.6	14.7
4294	Slag	75.9	94.2	19.4
4284	Slag	83.6	105.4	20.7
4334	Slag	67.9	92.3	26.4
4304	Slag	61.6	88.5	30.4

Flat and Elongated Pieces

The laboratory has devoted considerable effort to the measurement of flat and elongated pieces. Many specifications state that an aggregate shall be "free," "reasonably free," or "free from an excess" of flat and elongated pieces. The ASTM has separate definitions for flat pieces and elongated pieces which specify the dimensions to be considered, but it does not provide limiting ratios or a method of test. The AASHO defines thin or elongated pieces as those having a length greater than 5 times the average thickness. Again, no test procedure is provided. The difficulty with the AASHO definition is that the determination of the *average* thickness of an angular piece is an extremely arbitrary procedure.

One investigation was instigated by the proposal of a state highway department that the percentage of "thin" or elongated pieces (length greater than 5 times average thickness) be limited to 3 per cent by weight. The laboratory tested 23 samples representing most of the stone producers in this particular area. The results showed the proposed specification to be very restrictive in that less than one fourth of the samples met the requirement.

As a corollary to this study, the laboratory experimented with a procedure for determining the over-all *shape ratio* of a sample. This method consists of aligning all the pieces end to end and measuring the total length. Then the pieces are placed side by side to get the total width. The total thickness is obtained by placing the pieces on edge in a rack with spacers to support the pieces vertically. From this data it is possible to compute the ratios of length to width (L/W), width to thickness (W/T), and length to thickness (L/T). These measurements were also made separately on the "thin" pieces as determined by caliper measurements of length and average thickness.

The results of these tests are shown in Table IV. Here the samples have been arranged in order of decreasing ratio of length to width (L/T), that is, the most elongated samples at top and most chunky at bottom. There is a general agreement between the L/T ratio and the percentage of "thins." The percentage method appears to be more sensitive in that it provides a much greater range in values. On the other hand, the percentage of "thins" may be misleading. Consider Samples Nos. 4923 and 4930. The percentage of "thins" would indicate that No. 4923 with 7.6 per cent was more chunky than No. 4930 with 12.0 per cent. The L/T ratio for the "not-thin" portion of No. 4923 is the same as that of the other sample including thins. The question immediately arises as to what is the more important factor, the over-all shape or the presence of a few elongated pieces. This matter requires more investigation.

These results do provide a clue to a better method for measuring thin pieces. Considering the average

TABLE IV

Flat and Elongated Test Results. Test samples 3 to 1 in. in size

Lab No.	Entire Sample L/W	Entire Sample W/T	Entire Sample L/T	5:1 Thin Pieces[1] L/T	5:1 Thin Pieces[1] Per cent	Remainder L/T	Remainder Per cent
4925	1.41	1.87	2.63	4.25	14.9	2.39	85.1
4936	1.51	1.68	2.54	4.72	13.3	2.32	86.7
4923	**1.50**	**1.69**	**2.53**	**4.41**	**7.6**	**2.42**	**82.4**
4933	1.51	1.65	2.51	4.10	7.6	2.40	82.4
4939	1.48	1.69	2.50	4.54	10.2	2.31	89.8
4941	1.47	1.67	2.46	4.14	12.2	2.26	87.8
4938	1.45	1.69	2.45	4.08	8.6	2.36	91.4
4929	1.49	1.64	2.44	4.53	7.9	2.31	92.1
4930	**1.44**	**1.68**	**2.42**	**4.19**	**12.0**	**2.23**	**88.0**
4934	1.42	1.68	2.38	4.11	6.3	2.29	93.7
4935	1.51	1.56	2.36	4.18	8.0	2.20	92.0
4922	1.44	1.63	2.34	4.28	3.7	2.27	96.3
4932	1.42	1.64	2.33	4.01	9.3	2.18	90.2
4937	1.44	1.62	2.33	4.27	8.8	2.19	91.2
4924	1.41	1.64	2.31	4.51	8.4	2.18	91.6
4918	1.40	1.63	2.28	4.14	2.8	2.23	97.2
4940	1.42	1.58	2.27	4.48	6.2	2.17	93.8
4921	1.44	1.56	2.25	4.36	3.5	2.19	96.5
4920	1.42	1.58	2.23	4.26	2.7	2.19	97.3
4928	1.43	1.50	2.15	3.94	3.4	2.11	96.6
4919	1.36	1.54	2.09	—	0.0	2.09	100.0
Average	1.44	1.62	2.33	4.25	6.9	2.24	93.1

[1] Length greater than 5 times average thickness

of the L/T ratios for thin pieces, it will be seen that the length is 4.25 times the maximum thickness for pieces which have lengths greater than 5 times their *average* thickness. Why not define a thin piece as one with length greater than 4 times the *maximum* thickness?

Bituminous Mixtures

The laboratory uses several methods for investigating the design, stability, and durability of bituminous mixtures. These include Marshall, Immersion-Compression, and circular track tests. When time is available, we tend to rely mainly on the circular track since it provides more realistic compaction and loading conditions. A recent acquisition has been a pug mill which was built and donated by one of our members. This pug mill is electrically heated and has a capacity of 100 lb. The pug mill is shown in Figure 5.

A typical investigation will include tests on both molded specimens and circular track sections. One case involved the requirement of a state specification that the aggregate be graded so as to have a certain amount of material of 80 to 200 mesh size. This requirement was a hardship on some stone producers because this particular size was lacking in normal production. Tests were performed on mixtures with varying percentages of 80 to 200 mesh material. It was concluded from these tests that the required amount was not necessary. The specification limit was subsequently lowered.

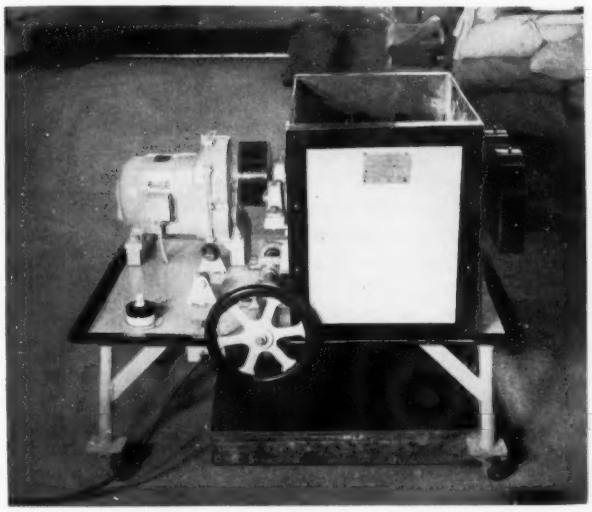

FIGURE 5
Pug Mill for Bituminous Mixtures

A different type of investigation was the development of the vacuum saturation technique for measuring the maximum specific gravity of bituminous mixtures.[1] This procedure has been adopted by several agencies and is presently the subject of a cooperative test program sponsored by the Highway Research Board. The preliminary results of this cooperative program indicate very satisfactory agreement among the participating laboratories.

Pavement Slipperiness

With the increase in traffic speed and volume, pavement slipperiness is becoming a critical problem. While slipperiness may be due to several different factors, certain aggregates tend to polish under the action of tire traffic, resulting in potentially dangerous conditions. The laboratory has used the circular track to test both portland-cement and bituminous concrete surfaces for skid resistance. One investigation involved the study of various fine aggregates for portland-cement concrete pavement. A total of 56 sections were placed in the track. The fresh concrete surfaces were finished with a burlap drag in order to roughen the surface and expose the particles of fine aggregate. In one series of sections, different sizes and types of hard, gritty aggregates were added to the surface of the plastic concrete. These surface treatments were applied so as to obtain a uniform coverage, and then vibrated into place. After curing, sections were subjected to wear and polishing by the combined action of a rolling truck tire dragging a weighted rubber mat over the surface sprinkled with water and fine sand.

The relative slipperiness was measured by the bicycle wheel apparatus shown in Figure 6. This wheel is fitted with a weight attached to the rim, and the tread is removed from a portion of the tire. The wheel is supported so that it turns freely when the treadless portion of the tire is in the low position. When the thick portion of the tire tread is in contact, the axle is raised slightly so that the full weight of the wheel rests on surface being tested. The procedure is to bring the eccentric weight to the top position, release the wheel, and measure the angle through which the wheel spins while being brought to rest by frictional force between tire and surface. The greater the angle, the more slippery the surface.

The results of this investigation were quite interesting. The abrasive action of the applied traffic in many cases wore down the particles of fine aggregate and produced a smooth, slippery surface. The degree of slipperiness seemed to be generally, but not conclusively, related to the hardness of the aggregate. Possibly the most significant result was the benefit that could be effected by the incorporation of a relatively small amount of hard aggregate in the surface. Material of about 1/4 to 1/8 in. size applied at a rate of about 5 lb per sq yd gave excellent results. Where skid-resistant aggregates are not abundant, the economical practice would be to use them only in the top surface where they are needed rather than throughout the entire 8 to 10 in. of depth.

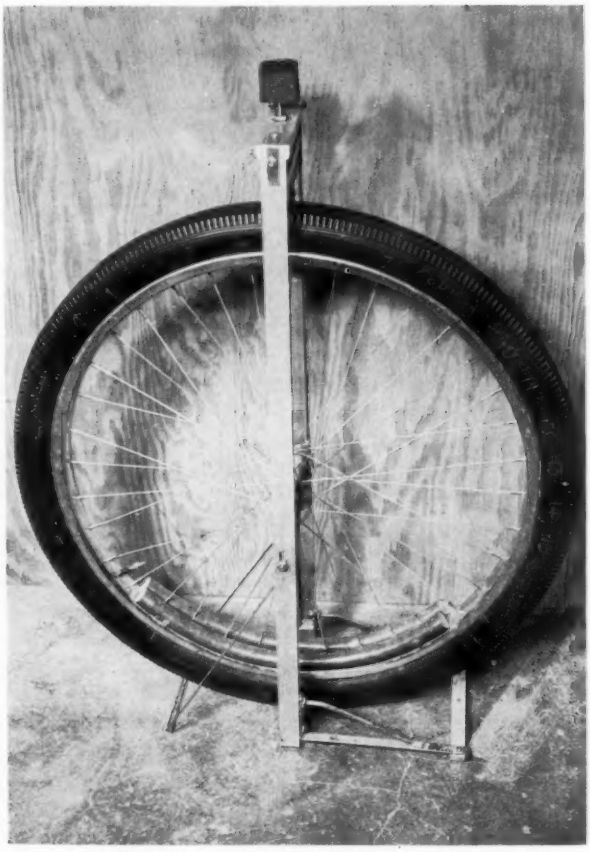

FIGURE 6
Bicycle Wheel Apparatus for Measuring Slipperiness

Bituminous concrete surfaces present a somewhat different problem. It should first be mentioned that the aggregate is not necessarily the offender, since many blacktop roads are slick due to an excess of

[1] See *Crushed Stone Journal*, September 1953

asphalt. Another important difference from a portland-cement concrete surface is that the bituminous binder does not hold small particles of aggregate rigidly in place as does cement. The fine aggregate tends to be dislodged and whipped off by traffic, exposing the coarse aggregate to wear and polish much sooner. A third factor is that bituminous wearing courses are laid in depths of about 1 in., so remedial measures need be applied to only a small portion of the total pavement thickness.

The laboratory is presently investigating this problem with reference to one aggregate which apparently develops a slippery surface under heavy traffic. Our findings to date indicate that, for this particular aggregate, beneficiation could be obtained by several methods. Listed roughly in order of decreasing effectiveness, these were:

1. By replacing a portion of the slippery coarse aggregate with a non-slippery one, and retaining the slippery fine aggregate. In this case, the coarse aggregate seemed to be the controlling factor since it tended to project slightly above the surface.

2. By changing the aggregate proportions so as to reduce the amount of slippery coarse aggregate in a mixture containing a non-slippery fine aggregate.

3. By retaining the slippery coarse aggregate but replacing a portion of the slippery fine aggregate with a non-slippery one.

A fourth solution would be to cover the slippery aggregate with a thin mat of non-skid material. In new construction, the binder course containing the slippery aggregate could be relatively thick, while the non-skid wearing surface could be placed in a mat 1/2 in. or less in thickness.

Other Activities

In a review of this nature it has been possible to describe but a few of the many problems that have been studied. Although the results of most of our research projects are of immediate value, occasionally an investigation will fail to provide any conclusive evidence. For example, several years ago the laboratory tested 65 samples of railroad ballast for the purpose of correlating service behavior with laboratory tests. While the findings did not establish the desired correlation, they did stimulate research activity to improve ballast test procedures. Recently we have been working on the applications of rubber-latex-cement compositions, and the development of dry-packaged concrete and mortar mixtures. Investigations such as these may not always provide information of immediate benefit to the stone industry but the knowledge gained will help us solve related problems that may arise in the future. It is this fund of knowledge, continued research activity, and adherence to high testing standards that enable the NCSA laboratory to serve the crushed stone industry.

United Front For a National Highway Program

(*Continued from Page 8*)

plete correction of all deficiencies on all the federal-aid systems.

12. We respectfully call attention to the comprehensive capacity studies made by 4 ARBA Task Forces, the findings of which were published earlier this year. These reports, dealing with the readiness and capacity of contractors, producers of materials and supplies, manufacturers, and the engineering profession generally, brought out the fact that a 10-year program on an accelerated basis could be carried on without undue economic dislocation or interference with normal construction activities. The question of industry and engineering capacities keeps bobbing up in Congressional debate and thus the careful findings of these national experts should be thoroughly understood and their significance underscored.

13. The 13th and final point that we would like to make is one dealing with acquisition of rights-of-way, particularly as it is applied to completion of the interstate system. Admittedly, rights-of-way acquisition in urban areas is a time-consuming and costly factor, but this is not necessarily the case in rural areas where the mileage is great and the problem of acquiring rights-of-way is not so difficult. Therefore, construction can get under way expeditiously, especially outside the cities.

Let me conclude this review of the principal problems and ARBA's position regarding them by emphasizing that the legislative task ahead, as a whole, is definitely one dealing with finance and not construction. But even so, the entire undertaking is of tremendous magnitude and surely nothing less than a bold, realistic approach over a definite period of years will ever accomplish the ultimate objective.

It has been a great pleasure to have this opportunity to report some of our current thoughts on a way in which we can all head into the job of presenting a united front in support of an accelerated national highway program. As I have said, these are simply suggestions as to a course which we might be able to follow together. Let's never lose sight of our goal—and that's swift steps toward safe, modern highways for a dynamic America.

Sixth Short Course of the National Crushed Stone Association

By A. T. GOLDBECK

Engineering Director
National Crushed Stone Association
Washington, D. C.

AGAIN a short course for salesmen has been completed successfully by the National Crushed Stone Association. This course of instruction is one of the many services offered to the members of the Association, and, judging by the growing attendance and the many voluntary expressions of approval, this seems to have become a service of ever increasing popularity and value.

Although in past years we have enjoyed the privilege of meeting in one of the beautiful assembly rooms of the U. S. Chamber of Commerce, it was thought to be desirable that we have our meeting this year at a hotel in which all of those attending could be housed instead of being dispersed in a number of different hotels. Accordingly, the Sixth Short Course was given at the Sheraton Park Hotel on December 6, 7, 8, and at the laboratory of the Association on December 9. This meeting place arrangement proved to be very satisfactory; it made for the advancement of acquaintanceships and for excellence of attendance at all of the sessions.

It might be of interest to know the reasons for giving these short courses. The production and sale of crushed stone has many ramifications, for the product has widely different characteristics from excellent to unacceptable, and it is used in many different ways. What are these various characteristics of stone, how are they determined, and why should stone be required to meet definite specifications?

There is certain background information stone producers should have in the business of producing and selling stone, not that such information will necessarily help to produce and sell stone, but those in the business are expected to know their product. Hence, the program contained the subject of Classification and Characteristics of Rocks Used for Construction.

The part which aggregate characteristics play in the design of pavements, and the proper use of stone in their construction were treated in papers on pavement design; and the uses of stone in different pavement types such as surface treatments, waterbound and stabilized aggregate base course, penetration macadam and bituminous concrete were ably presented by experts on those subjects.

Specifications were also discussed in papers on particle shape, reasons for the requirements in aggregate specifications, and deleterious materials in aggregates. Some very practical problems in bituminous concrete, including cracking, shoving, stripping, and the effect of high temperature on asphalt during shipment were treated, and finally, the proportioning of concrete and of bituminous concrete as practiced by NCSA were described and discussed.

Railroad ballast was presented in a very practical way by an expert on that subject from the Association of American Railroads. Fire resistance tests on concrete were ably described by an engineer from one of our member companies.

One full day was given over to exhibits and demonstrations of laboratory equipment, methods of testing, and to special research problems. It was not practicable to operate the testing machines to any extent because of the resulting noise and the crowded condition of the laboratory but, nonetheless, it was possible to show the laboratory equipment, describe its use, and give a good idea of the wide diversity of problems which we are called upon to solve for our member companies.

The Program

As in the past, the lectures were presented by members of the staff of the National Crushed Stone Association and by other engineers who were selected because of their wide experience in their special fields. These outside speakers were men of national, and even international reputation and we were exceedingly fortunate in having them talk to us.

The speakers, in alphabetical order, were as follows:

RUSSELL H. BRINK, *Highway Research Engineer*, Physical Research Branch, U. S. Bureau of Public Roads, Washington, D. C.

A. B. CORNTHWAITE, *Testing Engineer*, Commonwealth of Virginia Department of Highways, Richmond, Va.
A. T. GOLDBECK, *Engineering Director*, National Crushed Stone Association, Washington, D. C.
J. E. GRAY, *Field Engineer*, National Crushed Stone Association, Washington, D. C.
F. H. JACKSON, *Principal Engineer of Tests (Retired)*, U. S. Bureau of Public Roads, Washington, D. C.
E. B. KIRBY, *Professional Engineer*, New York Trap Rock Corporation, New York, N. Y.
CHARLES F. PARKER, *Chief Engineer*, W. H. Hinman, Inc., Gorham, Maine
H. M. REX, *Highway Physical Research Engineer*, Physical Research Branch, U. S. Bureau of Public Roads, Washington, D. C.
J. M. RICE, *Research and Testing Engineer*, National Crushed Stone Association, Washington, D. C.
ROCKWELL SMITH, *Research Engineer, Roadway*, Engineering Division, Association of American Railroads, Chicago, Ill.
J. E. WOOD, *Materials Engineer*, Maryland State Roads Commission, Baltimore, Md.

Subjects of Talks

Classification and Characteristics of Rocks Used for Construction
Laboratory Tests of Stone, Concrete, and Bituminous Concrete
The Sampling of Aggregates
The Reasons for the Requirements in Aggregate Specifications
Stone for Bituminous Surface Treatments
Shape of Particle, How Measured, Significance
Elements of Rigid Pavement Design
Waterbound Macadam; Stabilized Aggregate Base Course
Elements of Flexible Pavement Design
Deleterious Materials in Aggregates
Fire Resistance Tests on Concrete—Their Significance—The Rating of Aggregates for Fire Resistance
Penetration Macadam
Some Problems in Bituminous Concrete—Their Cure
  Cracking During Rolling
  Shoving
  Stripping
  Effect of Temperature of Asphalt During Shipment
  Slipperiness
The Proportioning of Bituminous Concrete
The Proportioning of Portland Cement Concrete
Stone for Railroad Ballast

Laboratory Demonstrations

Demonstrations and exhibits in the NCSA Laboratory for those interested in testing procedures included:

TESTS FOR STONE
  Deval Abrasion
  Los Angeles Abrasion
  Dorry Hardness
  Page Impact Test (for toughness)
  Specific Gravity and Absorption
  Particle Shape
  Sodium Sulfate
  Freezing Tests
  Comparator Measurements
  Alkali-Aggregate Reaction

CONCRETE TESTS
  Making and Testing Concrete Specimens
  Slump
  Weight per Cubic Foot
  Measurement of Entrained Air
  Freezing and Thawing
  Dynamic Modulus
  Slipperiness Tests of Concrete Pavements

BITUMINOUS CONCRETE
  Immersion-Compression Specimens and Tests
  Marshall Specimens and Tests

Among Those Present at the NCSA Sixth Short Course

Circular Track Tests for Durability and Stability
Stripping Tests
Tests for Slipperiness

Get-Together Party

On the evening of the first day's session a Get-Together Party, which evidently was attended by everyone, was held at the Sheraton Park Hotel. This is a sure way of getting acquainted and is a popular portion of the Short Course.

Attendance

The registration list showed 119 representatives from 42 companies, 11 speakers, and 28 guests, a total of 156.

The attendance was sustained at all of the sessions and the discussion which followed the papers and the attention paid to the speakers demonstrated very great interest by the audience. There is no question that this Short Course activity is a very popular one which should be repeated at frequent intervals in the future.

John J. Forbes Retires As Director U. S. Bureau of Mines

John J. Forbes, Director of the Bureau of Mines, retired after 40 years of Federal Service on November 30, 1955. President Eisenhower, Secretary of the Interior Douglas McKay, other Federal Government officials and Bureau employees paid tribute to Mr. Forbes in special ceremonies.

Born at Shamokin, Pennsylvania, November 21, 1885, Mr. Forbes spent most of his boyhood working in the anthracite coal region. After obtaining a teaching degree in 1905 from the State Normal School at Kutztown, he continued working and teaching before entering Pennsylvania State College where he received a bachelor of science degree in mining in 1911.

Joining the Bureau of Mines in 1915, Mr. Forbes served in the various progressive grades of mining engineer before being appointed as Supervising Engineer in July of 1927. He continued in that capacity until 1941 when named Chief Mine Inspector for the Bureau to supervise activities under the newly authorized Federal Coal Mine Inspection and Investigations Act of 1941. He won wide recognition for his administration of the Bureau of Mines emergency wartime functions through the Mineral Production Security Division, created in 1942 to insure continued production of vital war materials.

Upon conclusion of this program, Mr. Forbes was advanced to Assistant Chief of the Health and Safety Branch and again assumed supervision of the Coal Mine Inspection Division. Three years later he was appointed Chief of the Health and Safety Division and continued in that position until his Presidential appointment as Director of the Bureau in November of 1951.

Throughout his career, Mr. Forbes continuously emphasized the need for safety education in the coal, metal mining, and non-metallic industries. A milestone in this effort was attained in October of 1955 when coal miners in one United Mine Workers district achieved a 100 percent record for safety training.

Mr. Forbes has been author and co-author of many of the Bureau of Mines publications on mine health and safety, and has contributed many special articles to technical magazines and trade journals. He is active in numerous professional societies and organizations related to the mining industry.

John J. Forbes will long be remembered by the crushed stone industry for his outstanding work in the field of accident prevention. At the Annual Convention of 1954 and again in 1955, it will be recalled that Mr. Forbes presented the Safety Awards to the winners of the NCSA Safety Contest.

In his capacity as Director of the United States Bureau of Mines, his door was always open to members of our industry. We shall miss Mr. Forbes as Director of the Bureau of Mines and extend to him every good wish for many more years of health and happiness.

Construction Outlook Bright For 1956

New construction expenditures in 1956 may reach a record $44 billion, 5 percent over the 1955 peak, according to joint estimates of the Commerce and Labor Departments.

Substantial gains are expected in private non-residential and public construction. Public construction is expected to rise 10 percent—to more than $13 billion total. In view of the pressing needs for highways, schools, and sewer and water facilities, it is estimated that these three segments will account for three-fourths of the public construction expenditures—with each to reach a new high.

Manufacturers Division — National Crushed Stone Association

These associate members are morally and financially aiding the Association in its efforts to protect and advance the interests of the crushed stone industry. Please give them favorable consideration whenever possible.

Allis-Chalmers Mfg. Co.
Milwaukee 1, Wis.
Crushing, Screening, Washing, Grinding, Cement Machinery; Motors; Texrope Drives; Centrifugal Pumps; Tractors

American Cyanamid Co.
Explosives Department
30 Rockefeller Plaza, New York 20, N. Y.
Explosives and Blasting Supplies

American Hoist & Derrick Co.
63 South Robert St., St. Paul 1, Minn.
Crawler and Truck Cranes, Shovels, Draglines, and Clamshells; Locomotive and Gantry Cranes; Hoists, Derricks, and Wire Rope Clips and Fittings

American Manganese Steel Division
American Brake Shoe Co.
155 North Wacker Drive, Chicago 6, Ill.
Manganese and Alloy Steel Castings, Power Shovel Dippers, Material Handling Pumps, Reclamation and Hard-Facing Welding Materials

American Pulverizer Co.
1249 Macklind Ave., St. Louis 10, Mo.
Manufacturers of Ring Crushers and Hammermills for Primary and Secondary Crushing

American Steel & Wire Division
United States Steel
Rockefeller Bldg., 614 Superior Ave., N. W., Cleveland 13, Ohio
Wire Rope, Aerial Wire Rope Tramways, Electrical Wires and Cables, Welded Wire Fabric, Concrete Reinforcing, Wire Nails, Fencing, Netting

Aquadyne Corp.
62 LaSalle Road, West Hartford, Conn.
"Wet Water" Dust Control System

Atlas Powder Co.
Wilmington 99, Del.
Industrial Explosives and Blasting Supplies

Bacon-Greene & Milroy
29 Washington Ave., Hamden 14, Conn.
"Farrel-Bacon" Jaw Crushers for Primary and Secondary Operations, Conveyors, Elevators, Rolls, Screens

Baker-Raulang Corp.
314 West 90th St., Minneapolis 20, Minn.
Shovel Loaders (Front End)

Baldwin-Lima-Hamilton Corp.
Construction Equipment Division
South Main St., Lima, Ohio
Power Shovels, Draglines, Cranes, Bins, Conveyors and Idlers, Crushers and Pulverizers, Feeders, Plants—Crushing and Portable, Washing Equipment

Barber-Greene Co.
400 North Highland Ave., Aurora, Ill.
Portable and Permanent Belt Conveyors, Belt Conveyor Idlers, Bucket Loaders Both Wheel and Crawler Mounted, Asphalt Mixers and Finishers, Coal Handling Machines

Birdsboro-Buchanan Crusher Dept.
Birdsboro Steel Foundry & Machine Co.
1941 Furnace St., Birdsboro, Pa.
Primary and Secondary Crushers and Rolls

Boston Woven Hose & Rubber Co.
P. O. Box 1071, Boston 3, Mass.
Conveyor, Elevator, and Transmission Belt; V-Belts; Air Hoses; Suction Hose

Brunner & Lay Rock Bit of Asheville, Inc.
P. O. Box 5235, Asheville, N. C.
Tungsten Carbide Detachable Bits, "Rock Bit" Drill Steel Inlaid with Tungsten Carbide, Carbon Hollow Drill Steel, Alloy Hollow Drill Steel

Bucyrus-Erie Co.
South Milwaukee, Wis.
Excavating, Drilling, and Material Handling Equipment

Buda Division
Allis-Chalmers Mfg. Co.
Harvey, Ill.
Diesel and Gasoline Engines; Material Handling Equipment; Lifting Jacks; Earth Drills and Maintenance of Way Equipment

Burress, J. W.
1701 Shenandoah Ave., N. W., Roanoke, Va.
"Air-Trac" Drill Carrier

Cape Ann Anchor & Forge Co.
P.O. Box 360, Gloucester, Mass.
"Cape Ann" Forged Steel Drop Balls

Caterpillar Tractor Co.
Peoria 8, Ill.
Track-Type Tractors, Bulldozers, Earthmoving Scrapers, Motor Graders, Heavy-Duty Off-Road Hauling Units, Diesel Engines, Diesel Electric Generating Sets, Front End Shovels, Wheel-Type Tractors

Manufacturers Division—National Crushed Stone Association
(continued)

Chain Belt Co.
P. O. Box 2022, Milwaukee 1, Wis.
Rex Conveyors, Elevators, Feeders, Idlers, Elevator Buckets, Drive and Conveyor Chains, Sprockets, Bearings, Pillow Blocks, Power Transmission Equipment, Portable Self-Priming Pumps

Clark Equipment Co.
Construction Machinery Division
P.O. Box 599, Pipestone Road,
Benton Harbor, Mich.
Truck and Crawler Excavator Cranes—3/8, 1/2, 3/4 Cu. Yd.; Tractor Shovels—15 Cu. Ft. Through 2 1/4 Cu. Yd.; Michigan Turbo-Dozer 2 3/4 Cu. Yd.

Cleveland Rock Drill Division
Westinghouse Air Brake Co.
12500 Berea Road, Cleveland 11, Ohio
Rock and Wagon Drills; Jumbo Drill Rigs, Drifters, Stopers, Self Propelled Drill Rigs

Continental Gin Co.
4500 Fifth Ave., S., Birmingham 2, Ala.
Conveyors—Belt, Screw, Flight and Underground Mine; Elevators—Bucket and Screw; Feeders—Apron, Belt, Reciprocating, Table, and Screw; Drives—V-Belts, Chains and Sprockets, Gears and Speed Reducers

Contractors and Engineers
470 Fourth Ave., New York 16, N. Y.
Magazine of Modern Construction

Cross Engineering Co.
P. O. Box 507, Carbondale, Pa.
Cross Perforated Steel Segments, Sections, Decks, for Vibrating, Shaking, Revolving, and Other Types of Screening Equipment

Cummins Engine Co., Inc.
Fifth and Union Sts., Columbus, Ind.
Lightweight Highspeed Diesel Engines (60-600 Hp.) for: On-Highway Trucks, Off-Highway Trucks, Buses, Tractors, Earthmovers, Shovels, Cranes, Industrial and Switcher Locomotives, Air Compressors, Logging Yarders and Loaders, Oil Well Drilling Rigs, Centrifugal Pumps, Generator Sets and Power Units, Work Boats and Pleasure Craft

Dart Truck Co.
2623 Oak St., Kansas City 8, Mo.
Off Highway Trucks—End, Side, Bottom Dumps

Deister Machine Co.
1933 East Wayne St., Fort Wayne 4, Ind.
Deister Vibrating Screens, Classifiers, Washing Equipment

Detroit Diesel Engine Division
General Motors Corp.
13400 West Outer Drive, Detroit 28, Mich.
Light Weight, Compact 2 Cycle Diesel Engines and "Package Power" Units for All Classes of Service

Diamond Iron Works
Division Goodman Manufacturing Co.
Halsted Street & 48th Place, Chicago 9, Ill.
Jaw and Roll Crushers; Vibrator, Revolving, and Scrubber Screens; Drag Washers; Bucket Elevators; Belt Conveyors; Bins; Apron and Plate Feeders; Portable Gravel and Rock Crushing, Screening, and Washing Plants; Stationary Crushing, Screening, and Washing Plants; Hammermills

Du Pont, E. I., de Nemours & Co.
Wilmington 98, Del.
Explosives and Blasting Supplies

Dustex Corp.
1758 Walden Ave., Buffalo 25, N. Y.
Dust Collecting Equipment; Dust Control Systems

Eagle Crusher Co., Inc.
900 Harding Way East, Galion, Ohio
Crushers

Eagle Iron Works
129 Holcomb Ave., Des Moines 13, Iowa
Fine Material Screw Washers—Classifiers—Dehydrators; Coarse Material Screw and Log Washers—Dewaterers; Water Scalping and Fine Material Settling Tanks; Drop Balls—Ni-Hard and Semi-Steel; "Swintek" Screen Chain Cutter Dredging Ladders

Easton Car & Construction Co.
Easton, Pa.
Off-Highway Transportation: Dump Trailers, Truck Bodies, and Cars for Mines, Quarries, and Earth Moving Projects

Ensign-Bickford Co.
Simsbury, Conn.
Primacord-Bickford Detonating Fuse and Safety Fuse

Euclid Division
General Motors Corp.
1361 Chardon Road, Cleveland 17, Ohio
Heavy-Duty Trucks and Dump Trailers for "Off-Highway" Hauls, Loaders for Earth Excavation, Single and Twin Engine Earth Moving Scrapers

Frog, Switch & Mfg. Co.
Manganese Steel Dept.
Carlisle, Pa.
Manufacturers of "Indian Brand" Manganese Steel Castings for all Types of Jaw, Gyratory, and Pulverizing Crushers; Dippers, Teeth, Treads, and Other Parts for Power Excavating Equipment; and Other Miscellaneous Manganese Steel Castings. Manufacturers and Fabricators of Railroad and Mine Frogs, Switches, and Crossings

Manufacturers Division—National Crushed Stone Association
(continued)

General Electric Co.
1 River Road, Schenectady 5, N. Y.
Electric Motors, Controls, Locomotives, Welding Equipment, Coordinated Electric Drives for: Shovels, Drag Lines, Conveyors, Hoists, Cranes, Crushers, Screens, Etc.; Coordinated Power Generating and Distributing Systems Including Generators, Switchgear, Transformers, Cable, Cable Skids, Load Center Substations

Gill Rock Drill Co.
Lebanon, Pa.
Well Drill Tools and Supplies

Goodyear Tire & Rubber Co., Inc.
Akron 16, Ohio
Airfoam; Industrial Rubber Products—Belting (Conveyor, Elevator, Transmission), Hose (Air, Water, Steam, Suction, Miscellaneous); Chute Lining (Rubber); Rims (Truck and Tractor); Storage Batteries (Automobile, Truck, Tractor); Tires (Automobile, Truck, Off-the-Road); Tubes (Automobile, Truck, Off-the-Road, Life-Guard, Safety Tubes, Puncture Seal Tubes)

Gruendler Crusher and Pulverizer Co.
2915 North Market St., St. Louis 6, Mo.
Rock and Gravel Crushing, Screening and Washing Plants, Jaw Crushers, Roll Crushers, Hammermills, Lime Pulverizers

Gulf Oil Corp.
Gulf Refining Co.
Gulf Bldg., Pittsburgh 19, Pa.
Lubricating Oils, Greases, Gasoline and Diesel Fuels

Haiss, George, Mfg. Co., Inc.
Division of Pettibone Mulliken Corp.
5720 Empire State Bldg., New York 1, N. Y.
Bucket Loaders, Buckets, Portable and Stationary Conveyors, Car Unloaders

Harnischfeger Corp.
4400 West National Ave., Milwaukee 14, Wis.
A Complete Line of Power Excavating Equipment, Overhead Cranes, Hoists, Smootharc Welders, Welding Rod, Motors and Generators, Diesel Engines

HarriSteel Products Co.
420 Lexington Ave., New York 17, N. Y.
Woven Wire Screen Cloth

Hayward Co.
50 Church St., New York 7, N. Y.
Orange Peel Buckets, Clam Shell Buckets, Electric Motor Buckets, Automatic Take-up Reels

Heidenreich, E. Lee, Jr.
Consulting Engineers
75 Second St., Newburgh, N. Y.
Plant Layout, Design, Supervision; Open Pit Quarry Surveys; Appraisals—Plant and Property

Hendrick Mfg. Co.
Carbondale, Pa.
Perforated Metal Screens, Perforated Plates for Vibrating, Shaking, and Revolving Screens; Elevator Buckets; Test Screens; Wedge Slot Screens; Open Steel Floor Grating

Hercules Powder Co.
Wilmington 99, Del.
Explosives and Blasting Supplies

Hetherington & Berner Inc.
701-745 Kentucky Ave., Indianapolis 7, Ind.
Asphalt Paving Machinery, Sand and Stone Dryers

Hewitt-Robins Incorporated
666 Glenbrook Road, Stamford, Conn.
Belt Conveyors (Belting and Machinery); Belt and Bucket Elevators; Car Shake-outs; Feeders; Industrial Hose; Screen Cloth; Sectional Conveyors; Skip Hoists; Stackers; Transmission Belting; Vibrating Conveyors, Feeders, and Screens; Design and Construction of Complete Plants

Hoyt Wire Cloth Co.
Abraso St., P. O. Box 22, Lancaster, Pa.
Aggregate Wire Screens Made of Super-tough and Abraso Wire—Smoothtop, Longslot, Oblong Space and Double Crimp Construction—For All Makes of Vibrators

Hughes Tool Co.
P. O. Box 2539, Houston 1, Texas
Bits—Rock

Illinois Powder Mfg. Co.
506 Olive St., St. Louis 1, Mo.
Gold Medal Explosives

Ingersoll-Rand Co.
11 Broadway, New York 4, N. Y.
Rock Drills, Paving Breakers, Paving Breaker Tools and Accessories, Quarrymaster Drills, Drillmasters, Carset Bits, Jackbits, Bit Reconditioning Equipment, Portable and Stationary Air Compressors, Air Hoists, Slusher Hoists, Pneumatic Tools, Centrifugal Pumps, Diesel and Gas Engines

Insley Manufacturing Corp.
801 North Olney St., Indianapolis 6, Ind.
Concrete Carts and Buckets; 1/2 to 2 Cu. Yd. Cranes and Shovels—5 to 30 Tons Capacity—Rubber or Crawler Mounting

International Harvester Co.
Motor Truck Sales Dept.
180 N. Michigan Ave., Chicago 1, Ill.
Trucks, Trailers, Truck Bodies, Highway Trucks, Truck Bodies Off-Highway

Manufacturers Division—National Crushed Stone Association
(continued)

Iowa Manufacturing Co.
916 16th St., N.E., Cedar Rapids, Iowa
Rock and Gravel Crushing, Screening, Conveying and Washing Plants, Hot and Cold Mix Asphalt Plants, Stabilizer Plants, Impact Breakers, Screens, Elevators, Conveyors, Portable and Stationary Equipment, Hammermills, Bins

Jaeger Machine Co.
550 West Spring St., Columbus 16, Ohio
Portable and Stationary Air Compressors, Self-Priming Pumps, Truck Mixers, Concrete Mixers, Road Paving Machinery, Hoists and Towers; Rubber-Tired, Front End Loaders

Jeffrey Manufacturing Co.
East First Ave., Columbus 16, Ohio
Elevator Buckets; Car Pullers; Chains; Conveyors: Belt, Drag, Apron, Vibrating; Idlers; Crushers; Pulverizers; Elevators; Feeders; Pillow Blocks; Stationary Plants; Screens

Johnson-March Corp.
1724 Chestnut St., Philadelphia 3, Pa.
Dust Control Engineers, Wet and Dry Dust Collection Systems, Gas Scrubbers

Joy Manufacturing Co.
333 Henry W. Oliver Bldg., Pittsburgh 22, Pa.
Drills: Blast-Hole, Wagon, Rock, and Core; Air Compressors: Portable, Stationary, and Semi-Portable; Aftercoolers; Portable Blowers; Carpullers; Hoists; Multi-Purpose and Portable Rock Loaders; Air Motors; Trench Diggers; Belt Conveyors; "Spaders"; "String-a-Lite" (Safety-Lighting-Cable); Backfill Tampers; Drill Bits: Rock and Core

Kennedy-Van Saun Mfg. & Eng. Corp.
2 Park Ave., New York 16, N. Y.
Crushing, Screening, Washing, Conveying, Elevating, Grinding, Complete Cement Plants, Complete Lime Plants, Complete Lightweight Aggregate Plants, Synchronous Motors, Air Activated Containers for Transportation of Pulverized Material, Cement Pumps, and Power Plant Equipment

Kensington Steel Co.
505 Kensington Ave., Chicago 28, Ill.
Oro Alloy and Manganese Steel Castings: For Shovels—Dipper Teeth, Crawler Treads, Rollers, Sprockets; For Crushers—Jaw Plates, Concaves, Mantles, Bowl Liners; For Pulverizers—Hammers, Grate Bars and Liners; For Elevators and Conveyors—Chain, Sprockets, Buckets; For Tractors—Rail Links and Grouser Plates; Drag Line Chain

King Powder Co., Inc.
Cincinnati, Ohio
Detonite, Dynamites, and Blasting Supplies

Koehring Co.
3026 West Concordia Ave., Milwaukee 16, Wis.
Excavating, Hauling, and Concrete Equipment

Linde Air Products Co., Division of Union Carbide and Carbon Corp.
30 East 42nd St., New York 17, N. Y.
Oxygen, Acetylene, Welding and Jet Piercing Equipment and Supplies

Link-Belt Co.
300 West Pershing Road, Chicago 9, Ill.
Complete Stone Preparation Plants; Conveyors, Elevators, Screens, Washing Equipment, Speed-O-Matic Shovels—Cranes—Draglines and Power Transmission Equipment

Link-Belt Speeder Corp.
1201 Sixth St., S. W., Cedar Rapids, Iowa
Complete Line of Power Hydraulically Controlled Cranes, Shovels, Trench Hoes, Draglines, Clamshells, 1/2 to 3 Yd. Capacities. Available on Crawler Base or Rubber Tire Mounting

Lippmann Engineering Works
4603 W. Mitchell St., Milwaukee 14, Wis.
Primary and Secondary Rock Crushers and Auxiliary Equipment such as Feeders, Screens, Conveyors, Etc., Portable and Stationary Crushing and Washing Plants

Ludlow-Saylor Wire Cloth Co.
634 South Newstead Ave., St. Louis 10, Mo.
Woven Wire Screens and Wire Cloth of Super-Loy, Steel, and All Commercial Alloys and Metals

Mack Motor Truck Corp.
350 Fifth Ave., New York 1, N. Y.
On- and Off-Highway Trucks, Tractor-Trailers, Six-Wheelers, from 5 to 30 Tons Capacity, both Gasoline- and Diesel-Powered

Marion Power Shovel Co.
Marion, Ohio
Marion-Osgood-General — Power Shovels, Draglines, Cranes, Truck Cranes, Mobil Cranes—From 1/2 to 60 Yd.

McLanahan & Stone Corp.
252 Wall St., Hollidaysburg, Pa.
Complete Pit, Mine, and Quarry Equipment —Crushers, Washers, Screens, Feeders, Etc.

Manufacturers Division—National Crushed Stone Association
(continued)

Murphy Diesel Co.
5317 West Burnham St., Milwaukee 14, Wis.
Engines and Power Units—90 to 246 Hp.; Generator Sets—60 to 154 Kw.; Marine Engines—90 to 225 Hp.; Dual-Fuel Engines —135 to 180 Hp.; Mechanical and Electric Power Simultaneously

National Container Corp. of Ohio
Multi-Wall Paper Bag Division
Jaite, Ohio
Multi-Wall Paper Bags, Sewn and Pasted Style for Packaging Lime, Cement, Plaster, Etc.

New York Rubber Corp.
100 Park Ave., New York 17, N. Y.
Conveyor Belting: Stonore, Dependable, and Cameo Grades; Transmission Belting: Silver Duck Duroflex, Soft Duck Rugged, Commercial Grade Tractor

Nordberg Mfg. Co.
Milwaukee 1, Wis.
Symons Cone and Gyratory Crushers; Gyradisc; Grinding Mills; Stone Plant and Cement Mill Machinery; Vibrating Screens and Grizzlies; Diesel Engines and Diesel Driven Generator Units; Mine Hoists; Track Maintenance Machinery

Northern Blower Co.
6409 Barberton Ave., Cleveland 2, Ohio
Dust Collecting Systems, Fans—Exhaust and Blower

Northwest Engineering Co.
135 South LaSalle St., Chicago 3, Ill.
Shovels, Cranes, Draglines, Pullshovels—Crawler and Truck Mounted

Pennsylvania Crusher Division
Bath Iron Works Corp.
323 South Matlack St., West Chester, Pa.
Single Roll Crushers, Impactors, Hammermills, Ring Type Granulators, Kue-Ken Jaw Crushers, Kue-Ken Gyratories, Dixie Non-Clog and Standard Hammermills

Pettibone Mulliken Corp.
4710 West Division St., Chicago 51, Ill.
Material Handling Buckets, Clamshells, Draglines, Pullshovels, Dippers, Shovel Dippers, Pumps, Hammermills, Front End Loaders, Bucket Conveyor Loaders, Fork and Bucket Loaders, Speed Swing Loaders, Speed Swing Yard Cranes, Motor Graders, Manganese Steel Castings

Pioneer Engineering Works, Inc.
1515 Central Ave., N. E., Minneapolis 13, Minn.
Jaw Crushers, Roll Crushers (Twin and Triple), Vibrating and Revolving Screens, Feeders (Mechanical, Grizzly, Apron, and Pioneer-Oro Manganese Steel), Belt Conveyors, Portable and Stationary Crushing and Screening Plants, Washing Plants, Mining Equipment, Cement and Lime Equipment, Asphalt Plants and Finishers

Pit and Quarry Publications, Inc.
431 South Dearborn St., Chicago 5, Ill.
Pit and Quarry, Pit and Quarry Handbook, Pit and Quarry Directory, Concrete Manufacturer, Concrete Industries Yearbook

Productive Equipment Corp.
2926 West Lake St., Chicago 12, Ill.
Vibrating Screens

Quaker Rubber Corp.
Division of H. K. Porter Co., Inc.
of Pittsburgh
Tacony and Milnor Sts., Philadelphia 24, Pa.
Conveyor Belts, Hose, and Packing

Radio Corporation of America
Engineering Products Department
Industrial Equipment Section
Front and Cooper Sts., Bldg. 15-1, Camden 2, N. J.
Electronic Metal Detectors

Rock Products and Concrete Products
79 West Monroe St., Chicago 3, Ill.

Rogers Iron Works Co.
11th and Pearl Sts., Joplin, Mo.
Jaw Crushers, Roll Crushers, Hammermills, Vibrating Screens, Revolving Screens and Scrubbers, Apron Feeders, Reciprocating Feeders, Roll Grizzlys, Conveyors, Elevators, Portable and Stationary Crushing and Screening Plants, Mine Hoists, Drill Jumbos and Underground Loaders

Screen Equipment Co., Inc.
1754 Walden Ave., Buffalo 25, N. Y.
Seco Vibrating Screens; Scales—Industrial, Aggregates, Truck

Simplicity Engineering Co.
Durand, Mich.
Simplicity Gyrating Screens, Horizontal Screens, Simpli-Flo Screens, Tray Type Screens, Heavy Duty Scalpers, D'Watering Wheels, D'Centegrators, Vibrating Feeders, Vibrating Pan Conveyors, Car Shake-Outs, Woven Wire Screen Cloth

SKF Industries, Inc.
Front St. and Erie Ave., P. O. Box 6731, Philadelphia 32, Pa.
Anti-Friction Bearings—Self-Aligning Ball, Single Row Deep Groove Ball, Angular Contact Ball, Double Row Deep Groove Ball, Spherical Roller, Cylindrical Roller, Ball Thrust, Spherical Roller Thrust; Pillow Block and Flanged Housings—Ball and Roller

Manufacturers Division—National Crushed Stone Association
(concluded)

Smith Engineering Works

532 East Capitol Drive, Milwaukee 12, Wis.

Gyratory, Gyrasphere, Jaw and Roll Crushers, Vibrating and Rotary Screens, Gravel Washing and Sand Settling Equipment, Elevators and Conveyors, Feeders, Bin Gates, and Portable Crushing and Screening Plants

Stedman Foundry & Machine Co., Inc.

Aurora, Ind.

Stedman Impact-Type Selective Reduction Crushers, 2-Stage Swing Hammer Limestone Pulverizers, Multi-Cage Limestone Pulverizers, Vibrating Screens

Stephens-Adamson Mfg. Co.

Aurora, Ill.

Belt Conveyors, Elevators, Feeders, Car Pullers, Screens, Skip Hoists, Complete Plants

Taylor-Wharton Iron & Steel Co.

High Bridge, N. J.

Manganese and other Special Alloy Steel and Iron Castings; Dipper Teeth, Fronts and Lips; Crawler Treads; Jaw and Cheek Plates; Mantles and Concaves; Pulverizer Hammers and Liners; Asphalt Mixer Liners and Tips; Manganese Nickel Steel Welding Rod and Plate

Thew Shovel Co.

East 28th St. and Fulton Rd., Lorain, Ohio

"Lorain" Power Shovels, Cranes, Draglines, Clamshells, Hoes, Scoop Shovels on Crawlers and Rubber-Tire Mountings. Diesel, Electric, and Gasoline, 3/8 to 2 Yd. Capacities

Thor Power Tool Co.

175 North State St., Aurora, Ill.

Thor Power Tools

Torrington Co.
Bantam Bearings Division

3702 West Sample St., South Bend 21, Ind.

Anti-Friction Bearings; Self-Aligning Spherical, Tapered, Cylindrical, and Needle Roller; Roller Thrust; Ball Bearings

Travel Drill Co.

P. O. Box 1124, Raleigh, N. C.

"Travel Drill"—Mobile Drill for Secondary Drilling in Quarries and Open Pit Work

Traylor Engineering & Mfg. Co.

Allentown, Pa.

Stone Crushing, Gravel, Lime, and Cement Machinery

Trojan Powder Co.

17 North 7th St., Allentown, Pa.

Explosives and Blasting Supplies

Tyler, W. S., Co.

3615 Superior Ave., N. E., Cleveland 14, Ohio

Woven Wire Screens; Ty-Rock, Tyler-Niagara and Ty-Rocket (Mechanically Vibrated) Screens; Hum-mer Electric Screens; Ro-Tap Testing Sieve Shakers; Tyler Standard Screen Scale Sieves, U. S. Sieve Series

Unit Crane & Shovel Corp.

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